Series Parallel Ckts Troubleshooting

Unclassified:

3 Hour Conference W/4 Hr. PE1

Safety & Environmental Impact: “LOW”

Terminal Learning Objective

ACTION: Locate a malfunction in a series - parallel circuit.

CONDITIONS: Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130A electronics trainer, digital Multimeter w/test leads, PC-130-9A and PC-130-9B circuit cards, schematic diagrams, calculator and official OMEMS references.

STANDARDS: Be able to locate and identify an open, short, or changed value malfunction within a series - parallel circuit using proper procedures to the established standard of 7 correct answers out of 10 & 8 out of 10 for EOD.

Introduction

The Previous lesson provided a foundation utilizing both Series and Parallel circuit Voltage, Current and Resistance Laws to discover the normal operating parameters, anything that is contrary to the normal is considered a symptom.

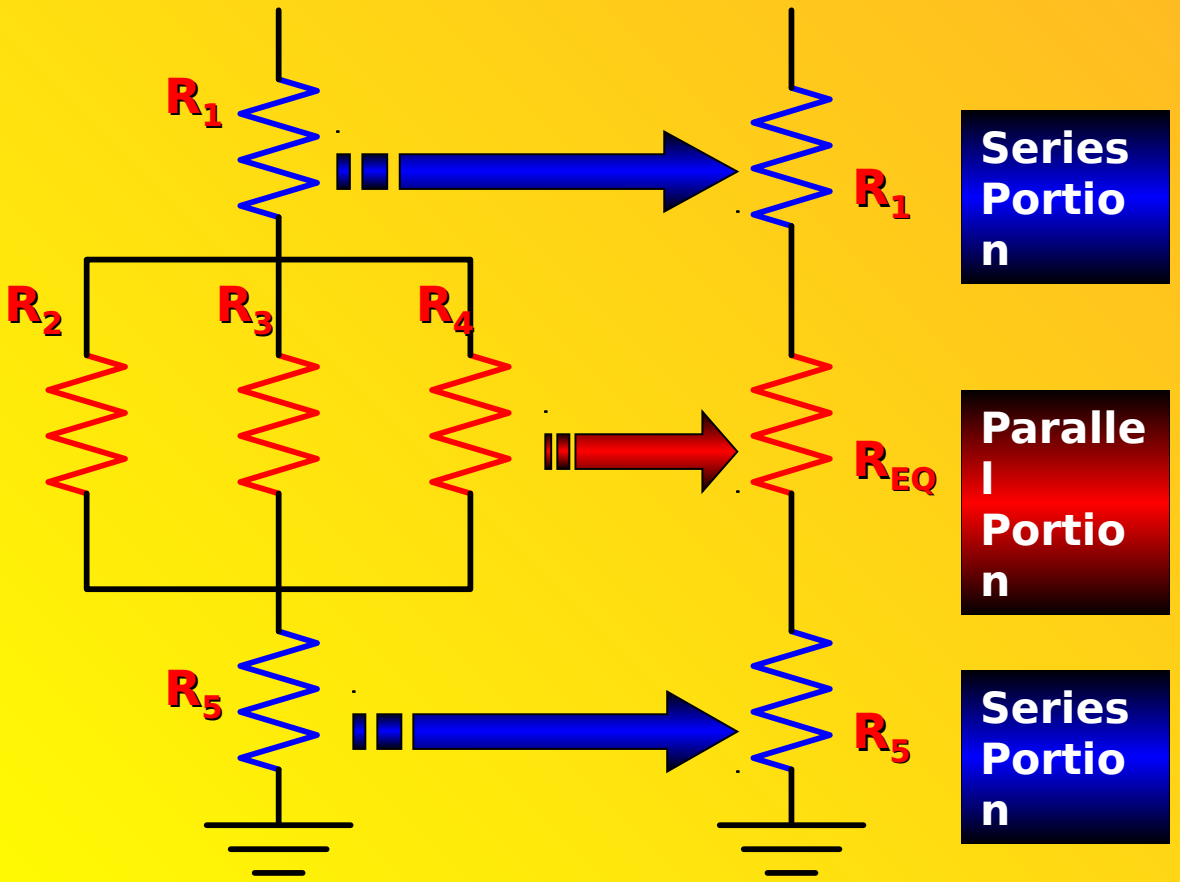
The logical breakdown and analysis of the symptoms will lead to a conclusion of the actual malfunction this procedure is called troubleshooting.

DC: Series - Parallel Ckts Troubleshootin

Troubleshooting a Series - Parallel Ckt is accomplished the same way the Series Ckt is shot. Reduce the Ckt down to a simple Series Ckt.

Voltage Drops will be the premier check.

Keep in mind which portion is Series & which is Parallel.



<u>Symptoms</u>, are indicators of Shorts or Opens.

A <u>Malfunction</u>, is a <u>Short</u> or <u>open</u>.

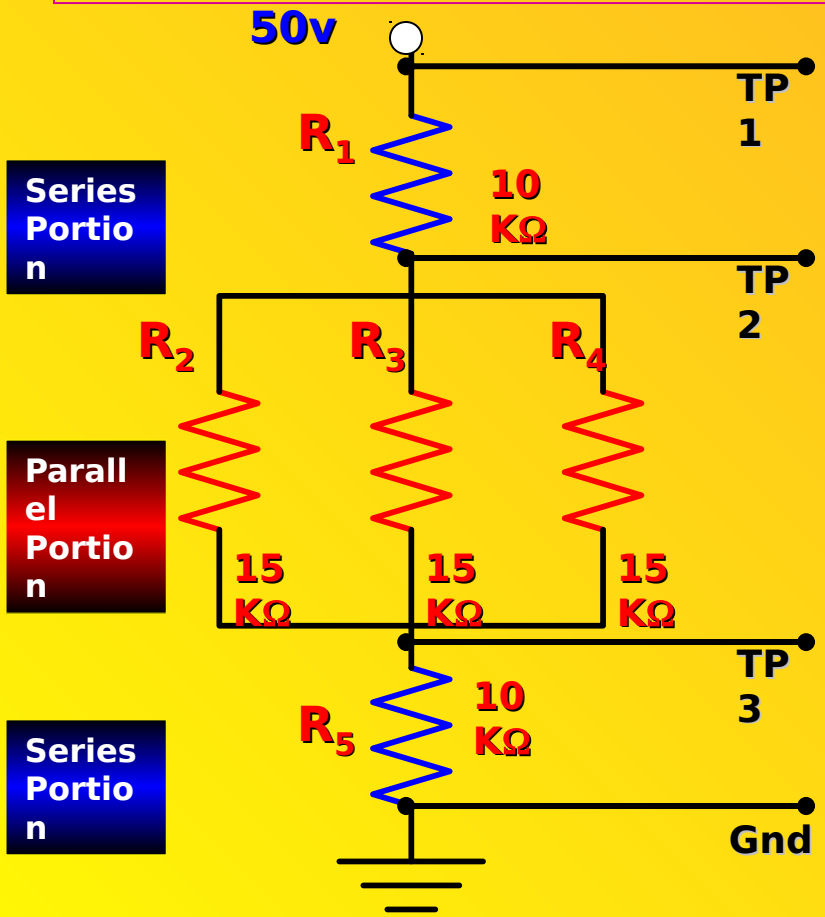
Use of Voltage, 1st √ .

Resistance the final confirmation √.

Challenge

DC: Series Parallel Ckts T- S, Normals

Calculate for the Normal operating parameters;
The point of reference that all symptoms are compared to.

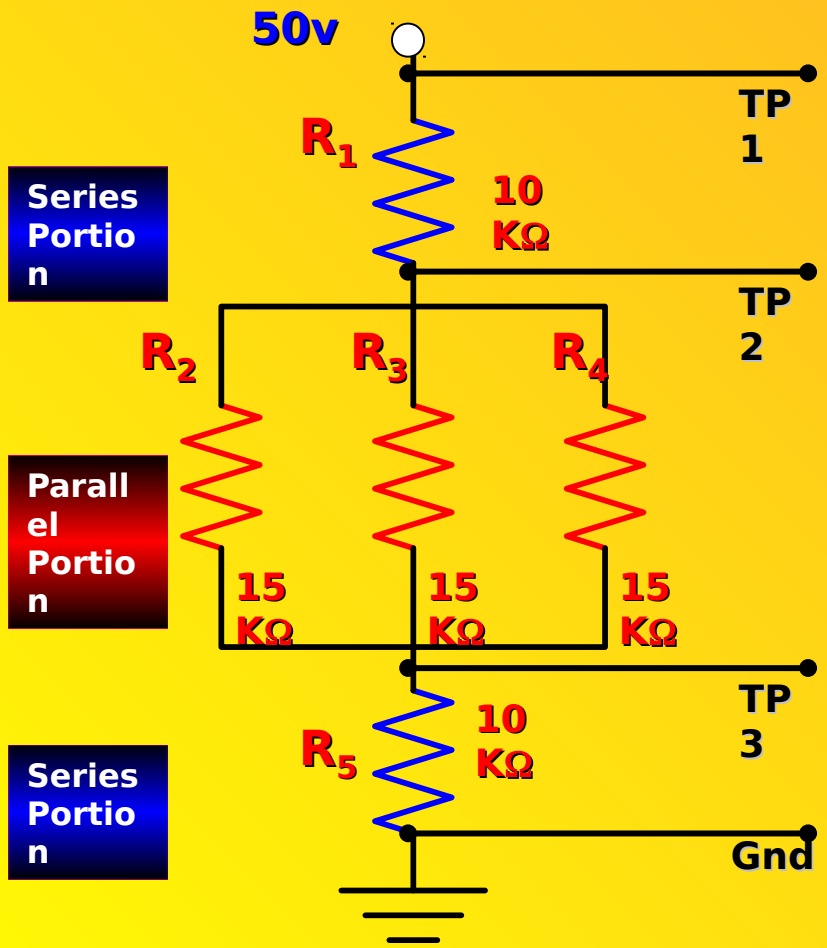


$I_T \times R_T =$	$E_A =$ _____
15/3 =	$R_{EQ} =$ _____
$R_{EQ} + R_1 + R_5 =$	$R_T =$ _____
$EA / R_T =$	$I_T =$ _____
$I_T \times R_1 =$	$E_{R1} =$ _____
$I_T \times R_{EQ}$	$E_{REQ} =$ _____
$I_T \times R_5 =$	$E_{R5} =$ _____
$E_{R5} + E_{REQ} + E_{R1} =$	$E_{TP1} =$ _____
$E_{R5} + E_{REQ} =$	$E_{TP2} =$ _____
$E_{R5} =$	$E_{TP3} =$ _____
$E_{REQ} \div R_2 =$	$I_{R2} =$ _____
$E_{REQ} \div R_3 =$	$I_{R3} =$ _____
$E_{REQ} \div R_4 =$	$I_{R4} =$

Answers

DC: Series Parallel Ckts T- S, Normals

Normal operating parameters, are the point of reference that all symptoms are compared to.



$I_T \times R_T =$ $E_A =$ 50v

15/3 = R_{EQ} = 5 KΩ

$R_{EQ} + R_1 + R_5 =$ R_T = 25 KΩ

EA / R_T = I_T = 2 mA

$I_T \times R_1 =$ E_{R1} = 20 v

$I_T \times R_{EQ}$ E_{REQ} = 10 v

$I_T \times R_5 =$ E_{R5} = 20 v

$E_{R5} + E_{REQ} + E_{R1} =$ E_{TP1} = 50 v

$E_{R5} + E_{REQ} =$ E_{TP2} = 30 v

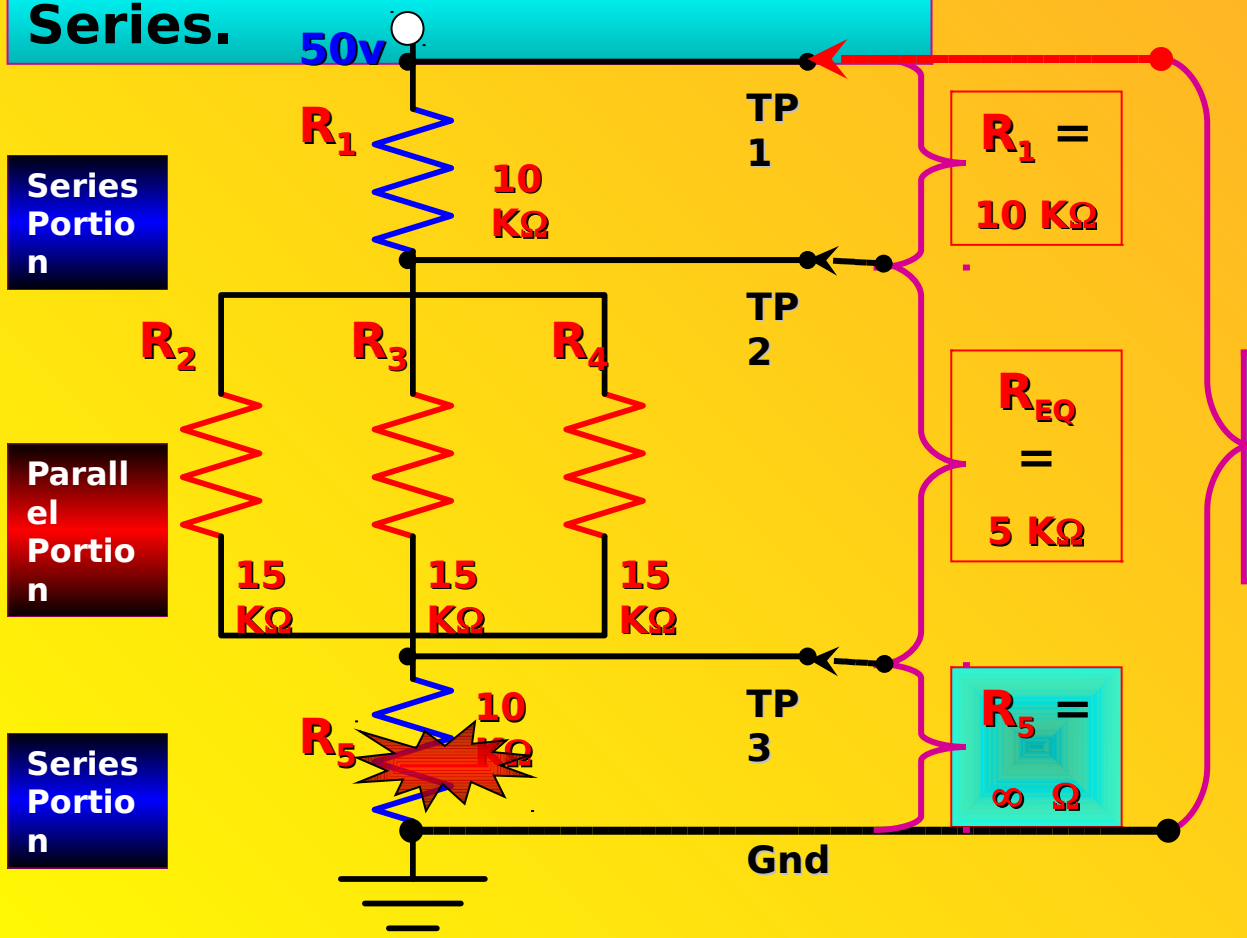
$E_{R5} =$ E_{TP3} = 20 v

IT ÷ 3 = I_{R2}

Opens; R

DC: Series Parallel Ckts T- S, Concepts

Resistance & R_T: Open in Series.



Normal's:

E_A = 50 v,

R_{EQ} = 5 KΩ,

R_T = 25 KΩ,

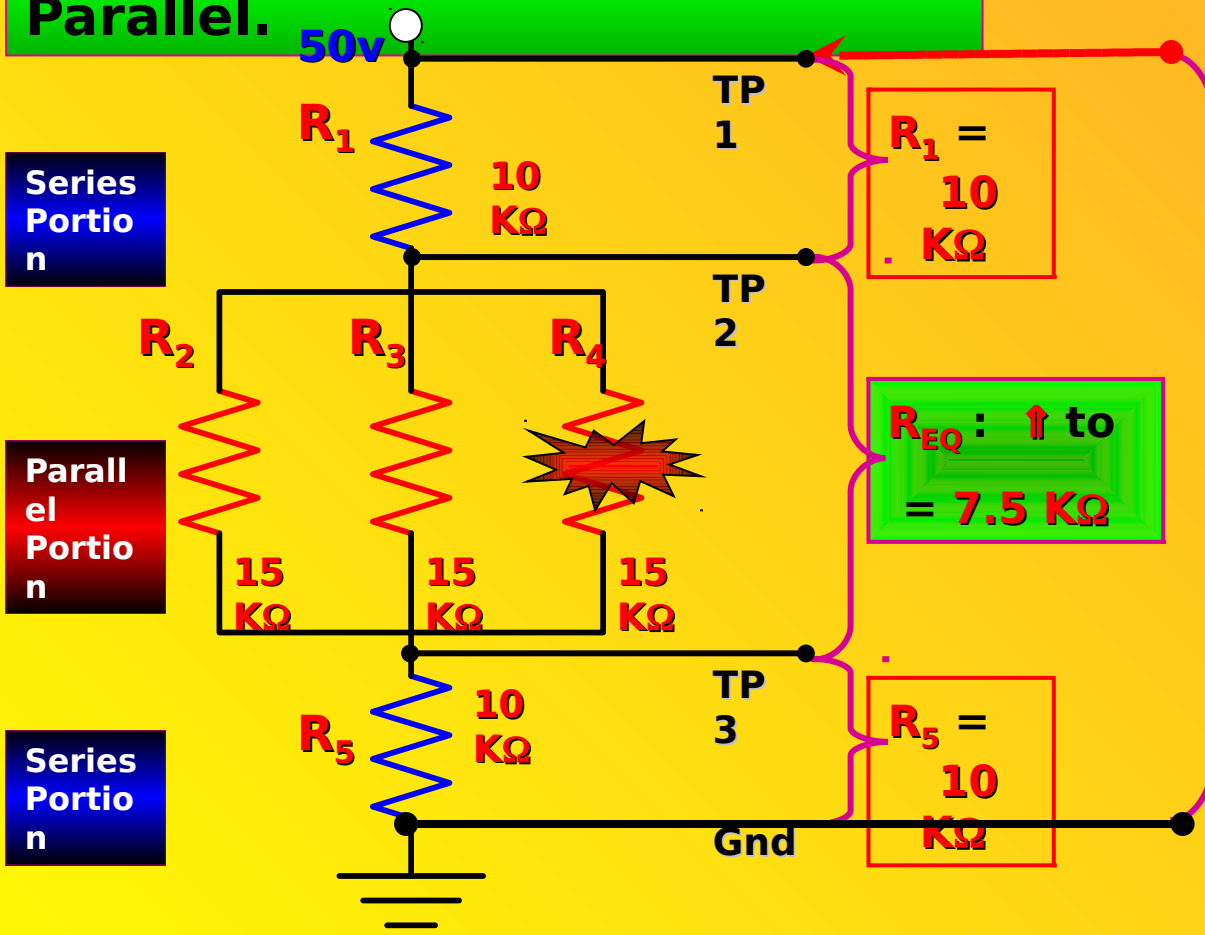
I_T = 2 mA

*** W/A OPEN in Series the entire Ckt ceases to function. In the Series portion there is only one path for Current,this path has been severed.**

Opens; R

DC: Series Parallel Ckts T- S, Concepts

Resistance & R_T: Open in Parallel.



R_1 = 10 KΩ

R_{EQ}: ⇑ to = 7.5 KΩ

R_5 = 10 KΩ

Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

R_T ▯ but not to ∞

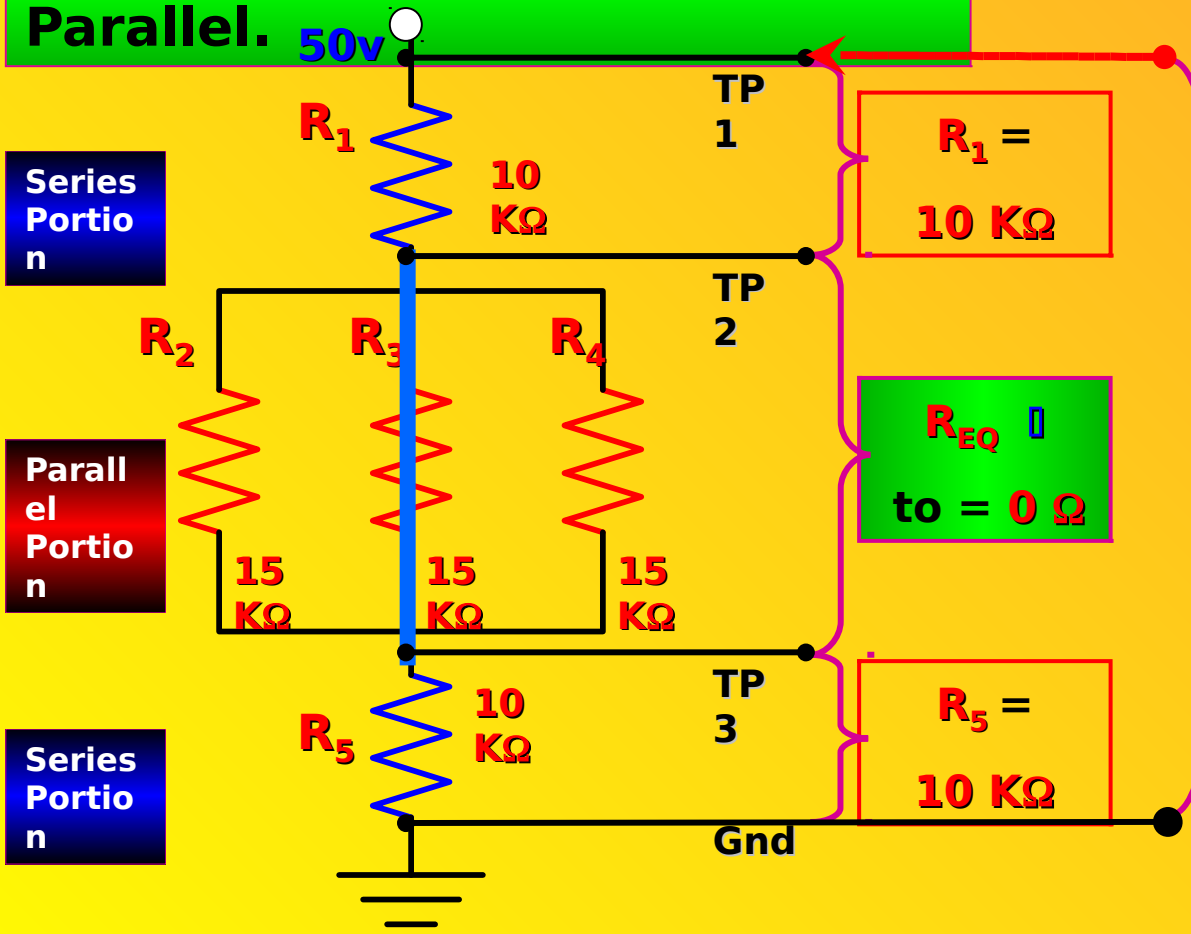
R_T ▯ to = 27.5 K Ω

* There is still a path for Current flow in the two remaining resistors in Parallel.

Shorts; R

DC: Series Parallel Ckts T- S, Concepts

Resistance & R_T: Short in Parallel.



R_1 = 10 KΩ

R_{EQ} ▯ to = 0 Ω

R_5 = 10 KΩ

R_T ▯ but not to 0Ω

R_T: ▯ to = 20 KΩ

Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

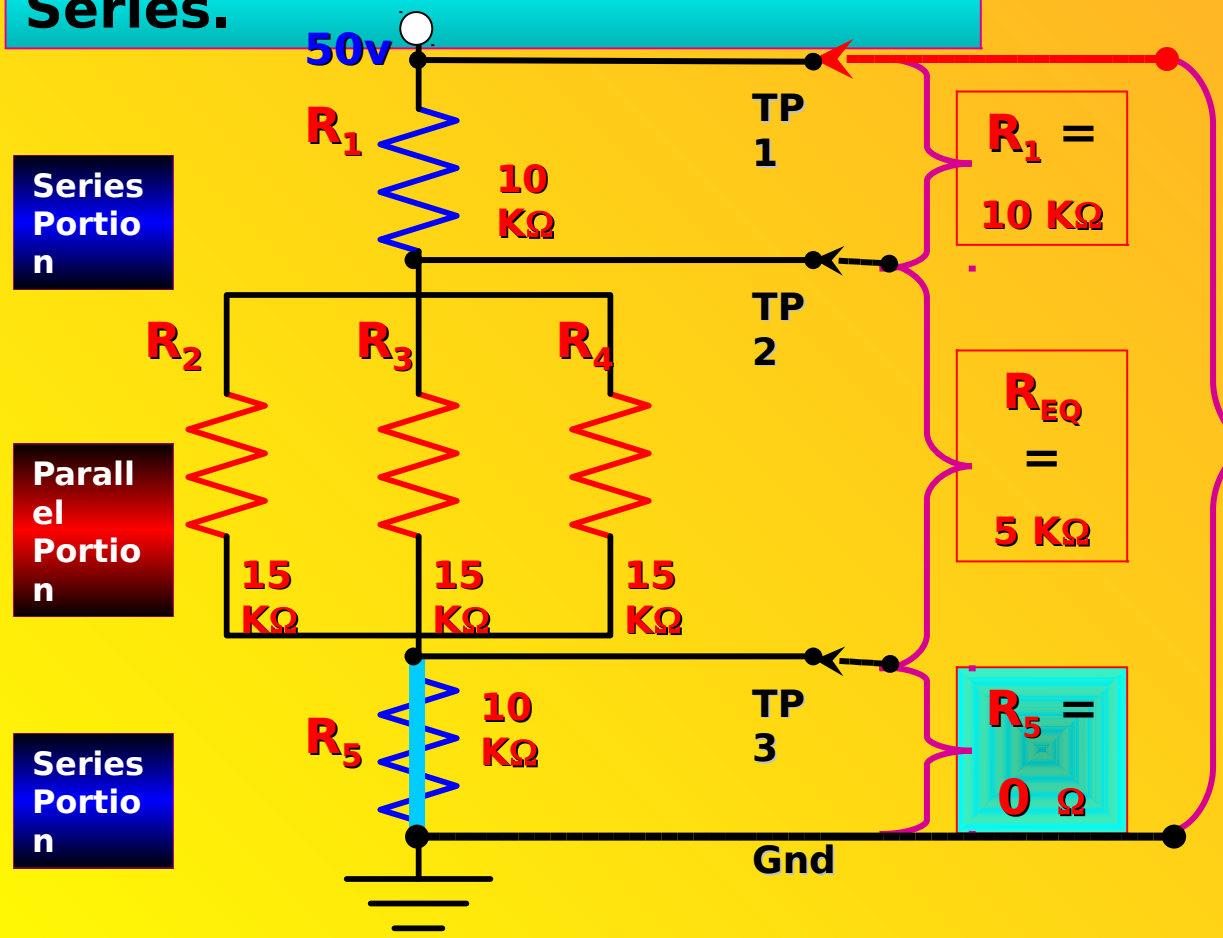
I_T = 2 mA

* **Current takes the path of least Resistance. A short in Parallel shorts the entire Parallel portion.**

Shorts; R

DC: Series Parallel Ckts T- S, Concepts

Resistance & R_T: SHORT in Series.



Normal's:

E_A = 50 v,

R_{EQ} = 5 KΩ,

R_T = 25 KΩ,

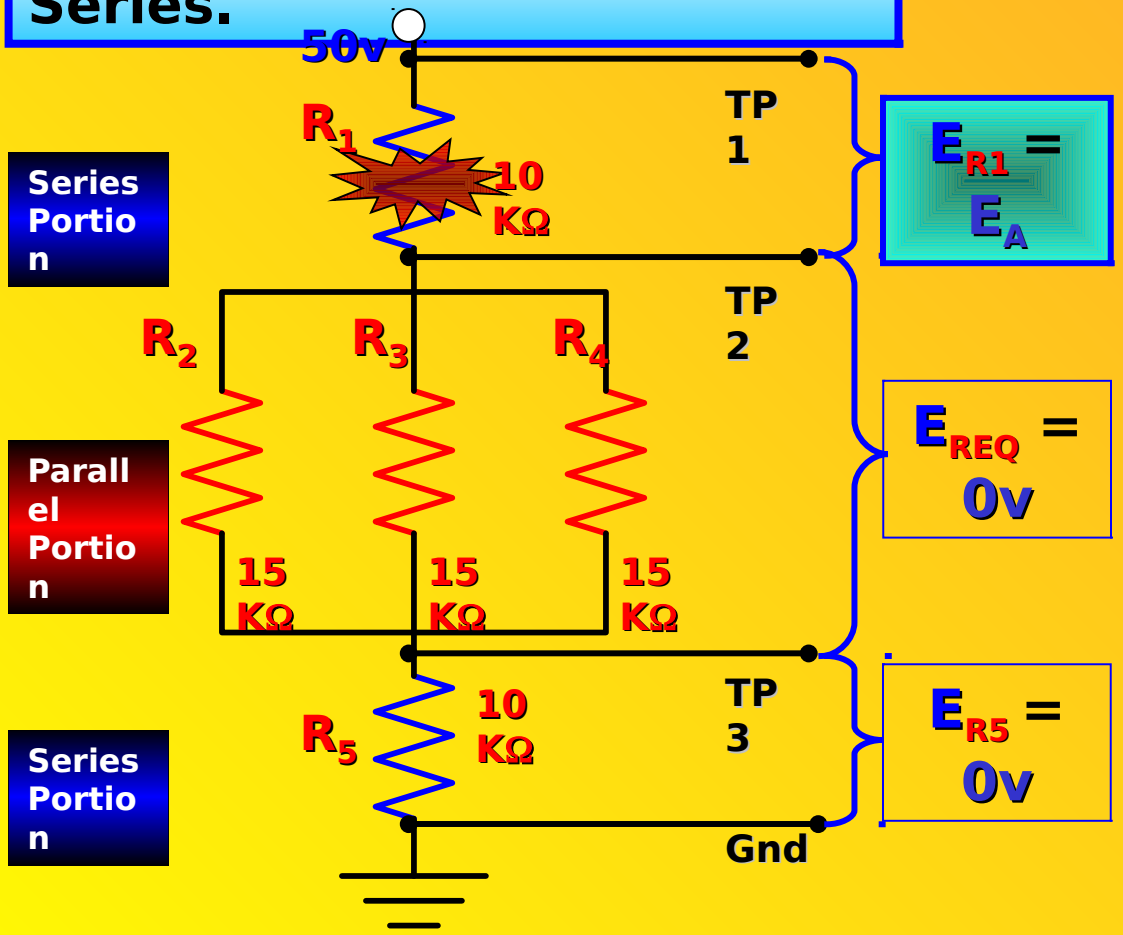
I_T = 2 mA

* A Short anywhere in the Ckt RT Decreases .

Voltages

DC: Series Parallel Ckts T- S, Concepts

Voltage Drops: OPEN in Series.



$E_{R1} = E_A$

$E_{REQ} = 0v$

$E_{R5} = 0v$

Normal's:

$E_A = 50$ v

$R_{EQ} = 5$ KΩ

$R_T = 25$ KΩ

$I_T = 2$ mA

$E_{R1} = 20$ v

$E_{REQ} = 10$ v

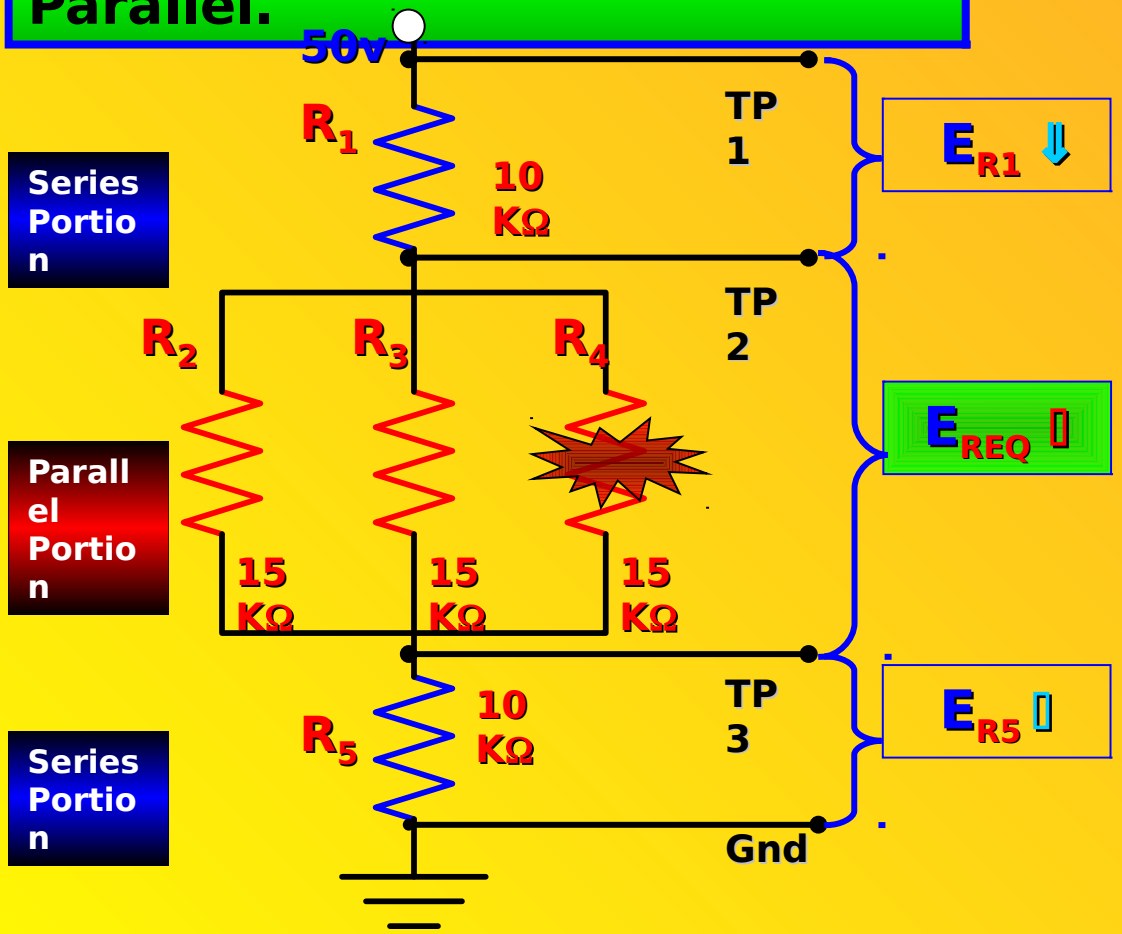
$E_{R5} = 20$ v

* The single path for Current flow has been severed, the meter completes the Ckt, all the Voltage is dropped on the meter.

Voltages

DC: Series Parallel Ckts T- S, Concepts

Voltage Drops: OPEN in Parallel.



E_{R1} ⇓

E_{REQ} ▯

E_{R5} ▯

Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} =10 v

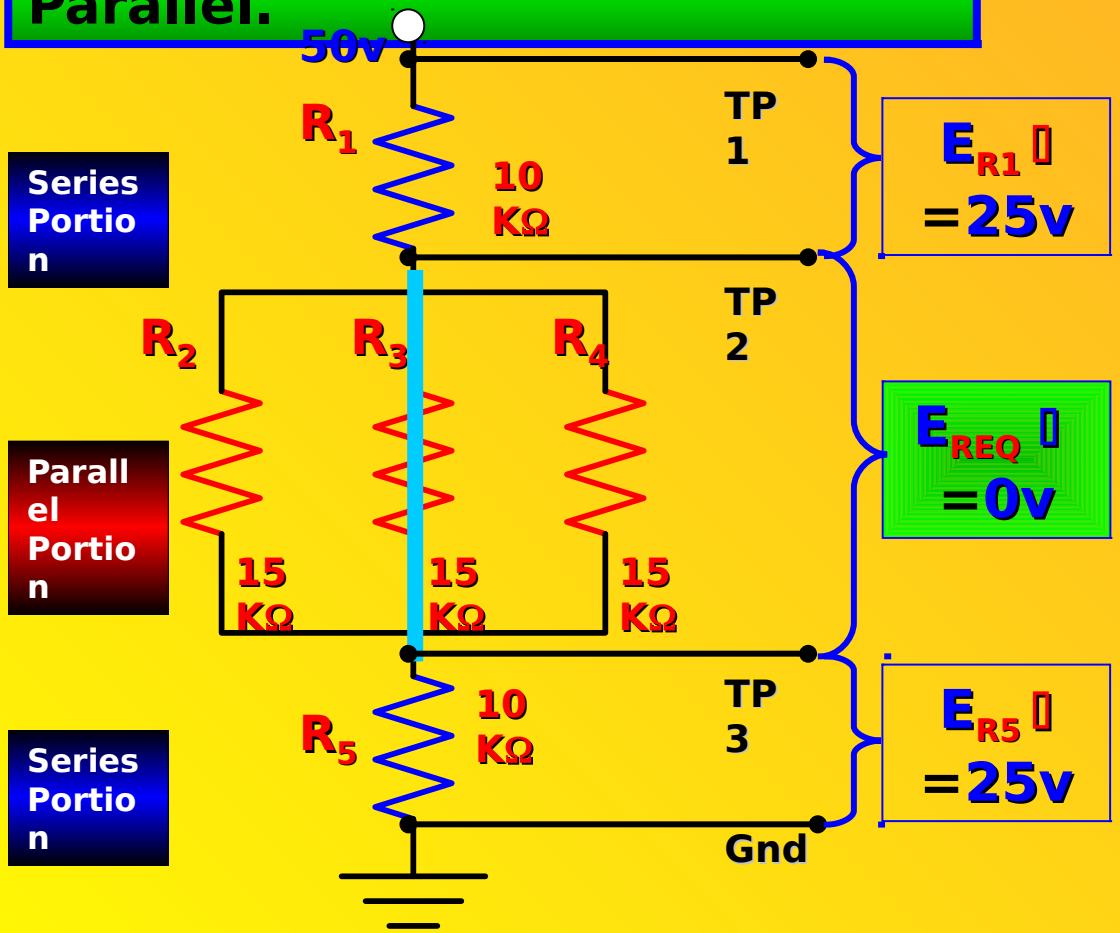
E_{R5} = 20 v

* An OPEN in Parallel causes the REQ to Increase, therefore the E_{REQ} Increases.

Voltages

DC: Series Parallel Ckts T- S, Concepts

Voltage Drops: SHORT in Parallel.



E_{R1} = 25v

E_{REQ} = 0v

E_{R5} = 25v

Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} = 10 v

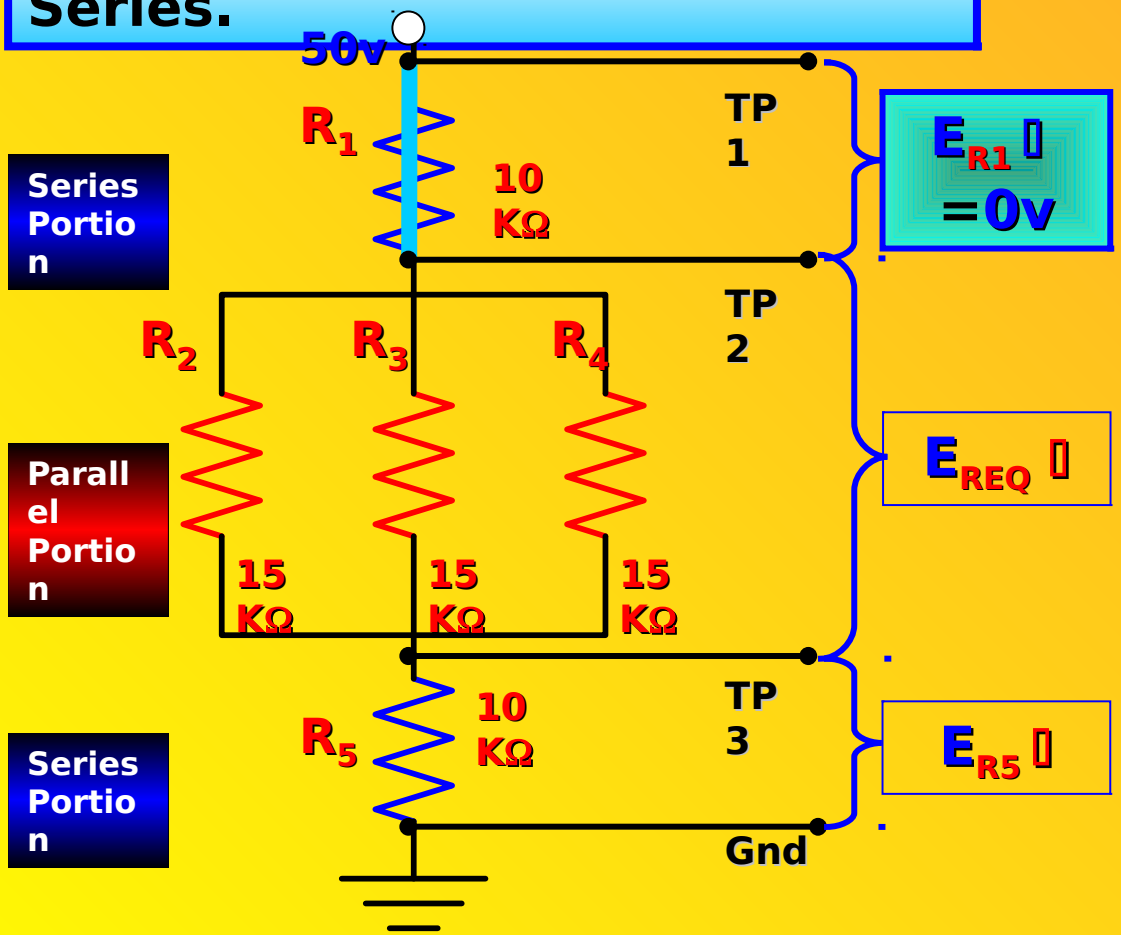
E_{R5} = 20 v

* A SHORT in Parallel causes the REQ to Decreases to 0 Ω, therefore the E_{REQ} Decreases to 0v.

Voltages

DC: Series Parallel Ckts T- S, Concepts

Voltage Drops: SHORT in Series.



Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} = 10 v

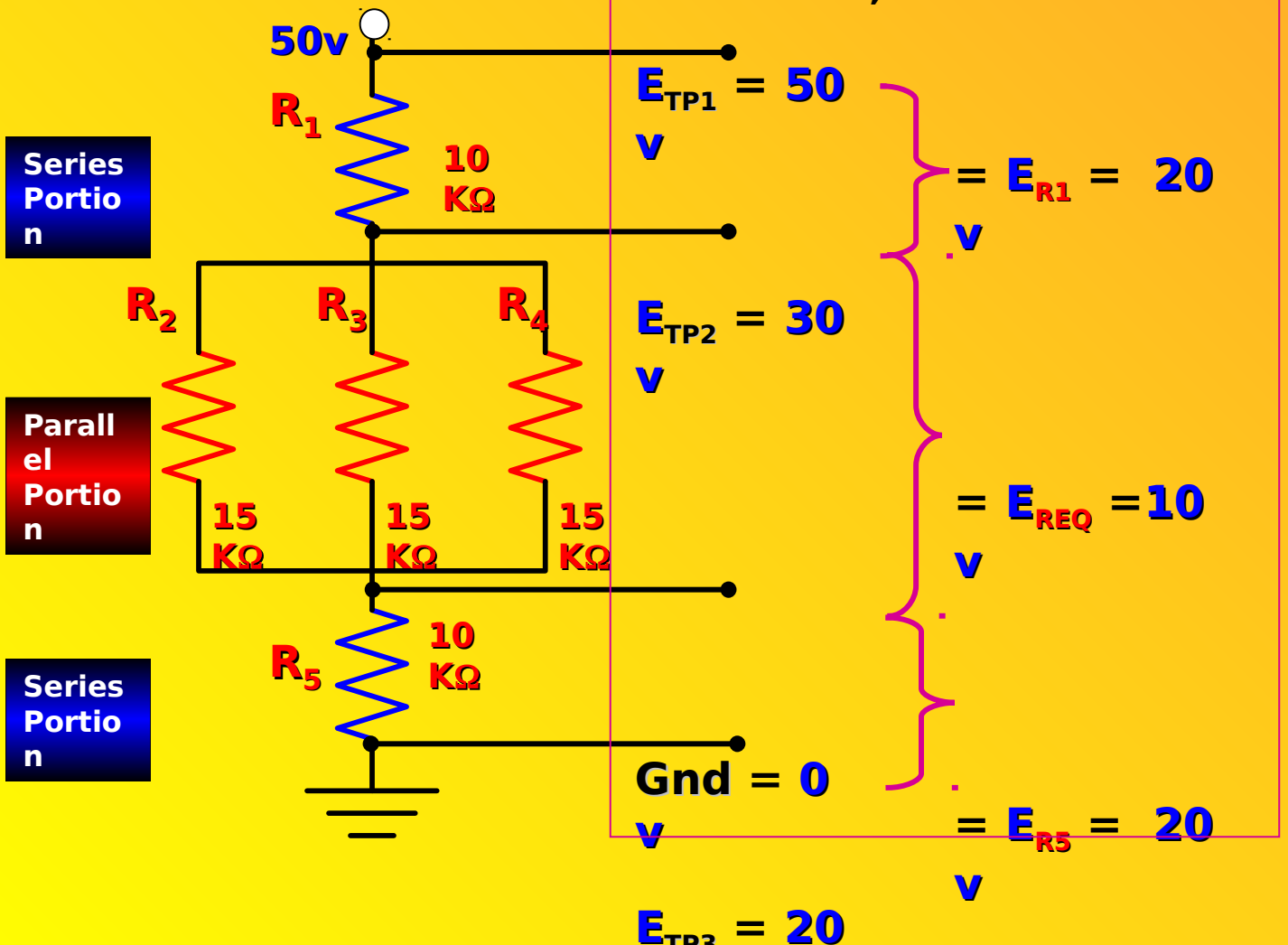
E_{R5} = 20 v

* A SHORT causes R_1 to Decreases to 0v, therefore the E_{REQ} & E_{R5} Sum Increase to = EA.

Voltages @ TP

DC: Series Parallel Ckts T- S, Concepts

Voltage @ Test Points: Reduce to Voltage Drops.



Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

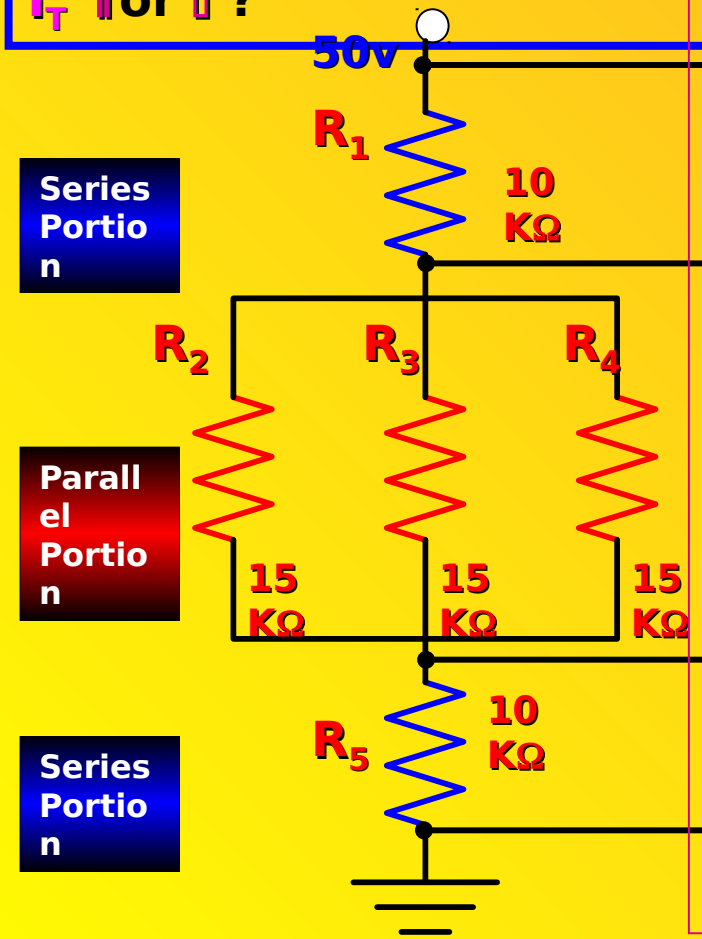
Bracket & Subtract:

Reduces the voltages @ T/P to a Voltage Drop, thus reveling an absolute symptom.

Voltages @ TP Challenge

DC: Series Parallel Ckts T- S, Concepts

Voltage @ Test Points: Reduce T/P Voltages to Voltage Drops & reveal the Component & Malfunction. Did R_T & I_T ↑or ↓ ?



Symptom V @ T/P

E_{TP1} = 50 v

E_{TP2} = 0 v

E_{TP3} = 0

Gnd = 0 v

E_{R1} = ?

E_{REQ} = ?

E_{R5} = ?

Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} = 10 v

E_{R5} = 20 v

E_{TP1} = 50 v

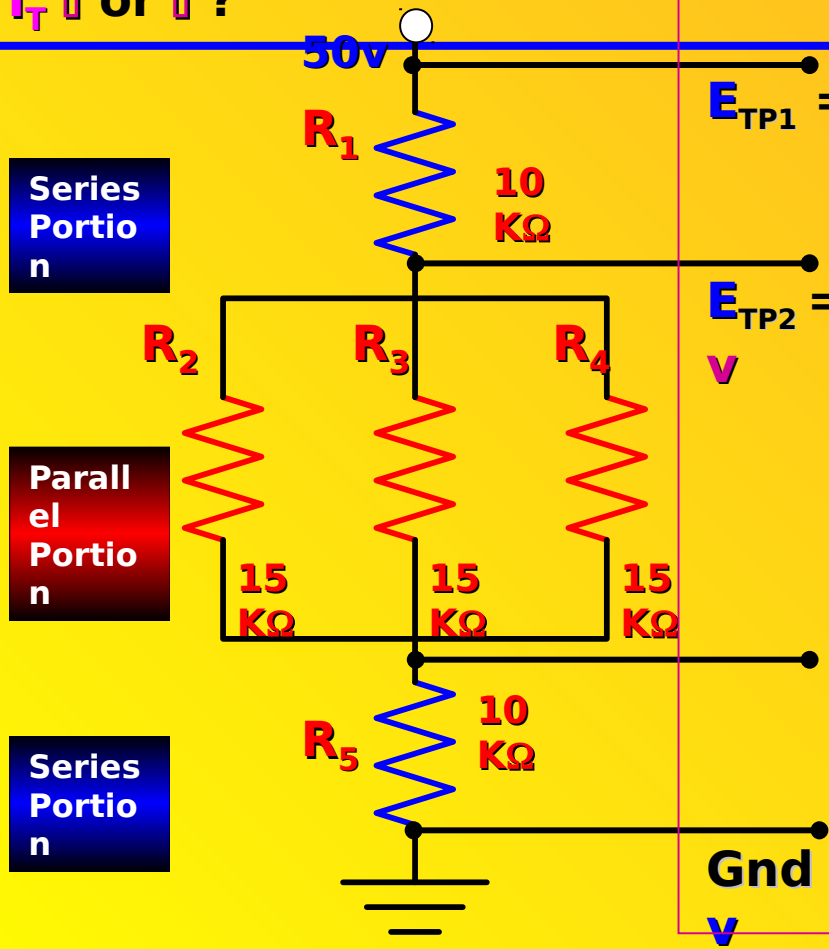
E_{TP2} = 30 v

E_{TP3} = 20 v

Next

DC: Series Parallel Ckts T- S, Concepts

Voltage @ Test Points: Reduce T/P Voltages to Voltage Drops & reveal the Component & Malfunction. Did R_T & I_T ▯ or ▯ ?



Symptom V @ T/P

E_{TP1} = 50 v

E_{TP2} = 31.8 v

E_{TP3} = 18.2 v

Gnd = 0 v

E_{R1} = ?

E_{REQ} = ?

E_{R5} = ?

Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} = 10 v

E_{R5} = 20 v

E_{TP1} = 50 v

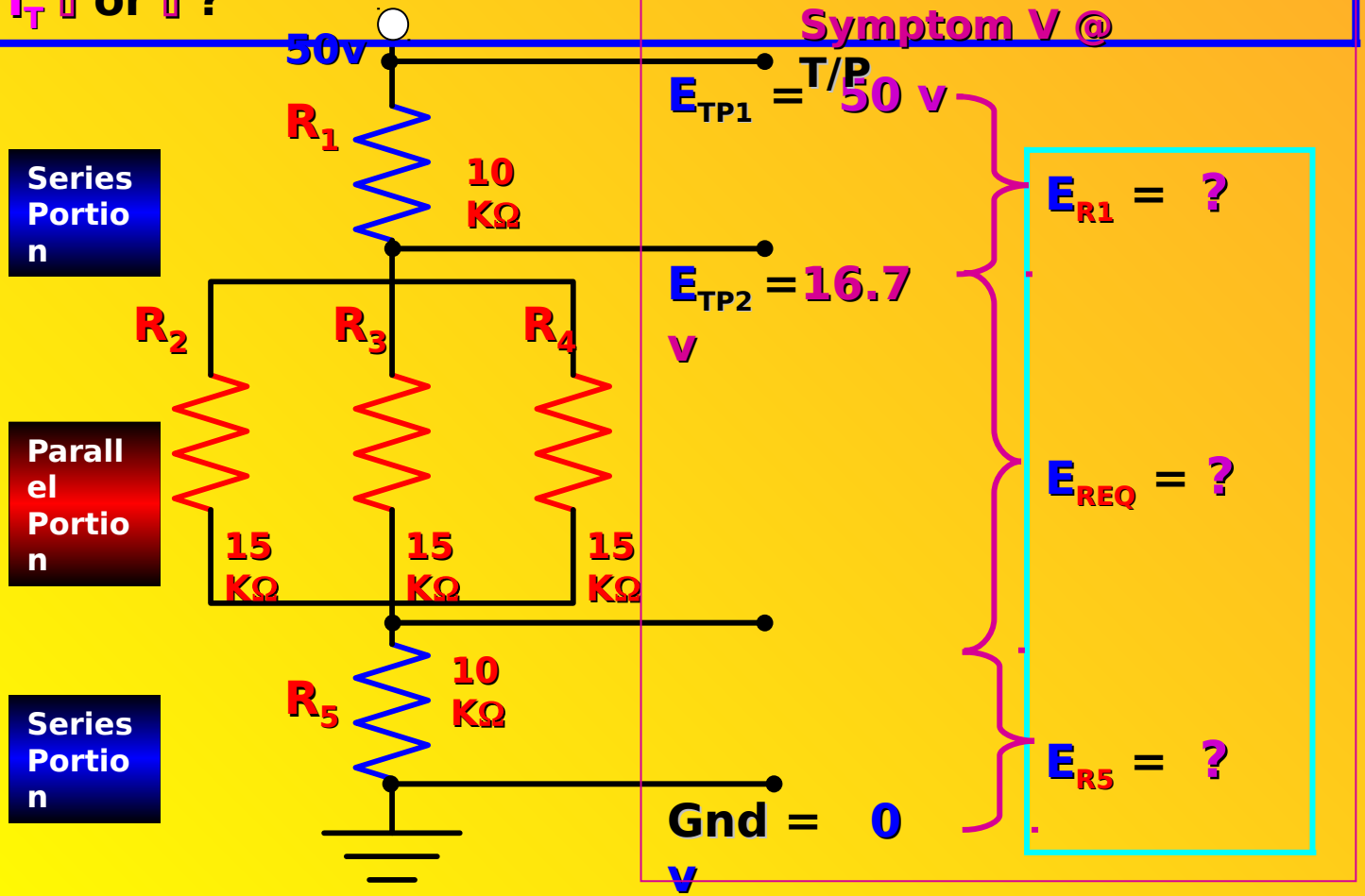
E_{TP2} = 30 v

E_{TP3} = 20 v

Next

DC: Series Parallel Ckts T- S, Concepts

Voltage @ Test Points: Reduce T/P Voltages to Voltage Drops & reveal the Component & Malfunction. Did R_T & I_T ▯ or ▯ ?



Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} = 10 v

E_{R5} = 20 v

E_{TP1} = 50 v

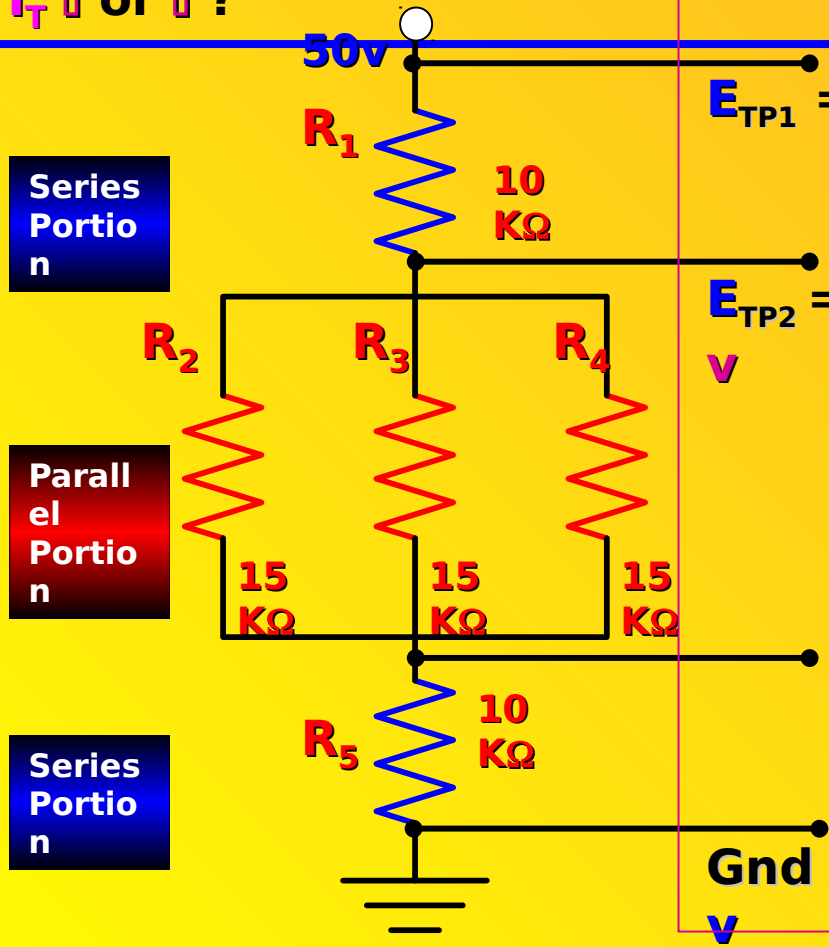
E_{TP2} = 30 v

E_{TP3} = 20 v

Next

DC: Series Parallel Ckts T- S, Concepts

Voltage @ Test Points: Reduce T/P Voltages to Voltage Drops & reveal the Component & Malfunction. Did R_T & I_T ▯ or ▯ ?



Symptom V @ T/P

E_{TP1} = 50 v

E_{TP2} = 25 v

E_{TP3} = 25 v

Gnd = 0 v

E_{R1} = ?

E_{REQ} = ?

E_{R5} = ?

Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} = 10 v

E_{R5} = 20 v

E_{TP1} = 50 v

E_{TP2} = 30 v

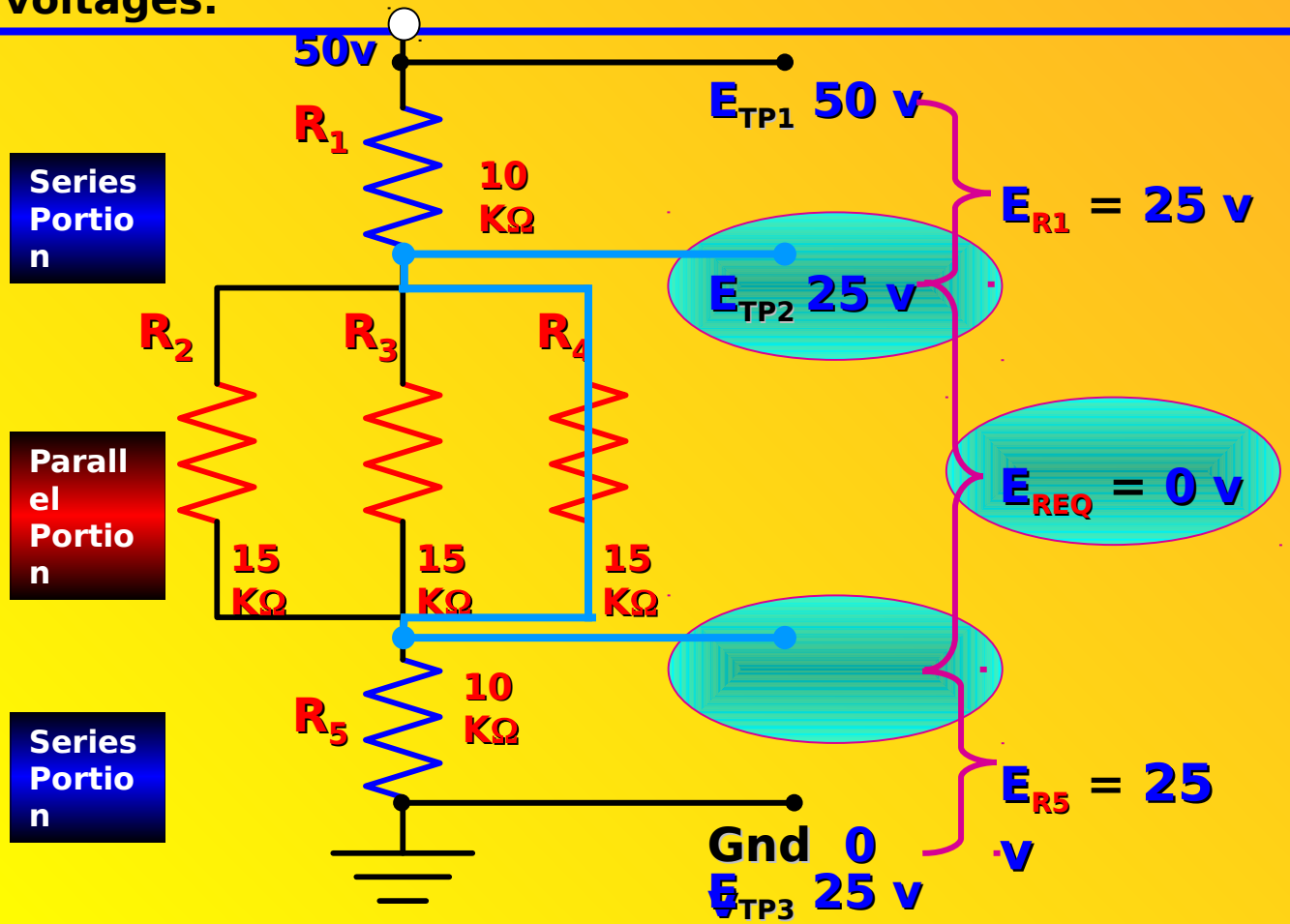
E_{TP3} = 20 v

Detail

DC: Series Parallel Ckts T- S, Concepts

Voltage @ Test Points Analysis:

Voltages @ TP2 & 3 are the Same, EREQ has gone to 0v this indicates a SHORT in the Parallel portion of the Ckt. R5 is dropping 25v seen @ TP3, Electrically TP2 is the same point as TP3, this is why we see the same voltages.



Normal's:

E_A = 50 v

R_{EQ} = 5 KΩ

R_T = 25 KΩ

I_T = 2 mA

E_{R1} = 20 v

E_{REQ} = 10 v

E_{R5} = 20 v

E_{TP1} = 50 v

E_{TP2} = 30 v

E_{TP3} = 20 v

R_T ▯ & I_T ▯

Matrix

DC: Series Parallel Ckts Troubleshooting

Series	
OPEN	**SHORT**
E EA	= 0v
I = 0 A	
R = ∞ Ω	= 0 Ω
Parallel	
E E_{REQ}	E_{REQ} = 0 v
I I_T , $I_{R\#}$ = 0 A	I_T , $I_{R\#}$
R R_{EQ}	R_{EQ} = 0 Ω

Current, Open in Series

DC: Series Parallel Ckts Troubleshooting

Lesson Test:

Standard: 10 Questions, W/in 20 minutes

70% Minimum Accuracy.

80% for EOD

References: Official OMEMS Training Aids.